No class Mon

Read 10.3 for Wed.

I'll post webwork soon
but it will be due next week
(so no webwork due this Sun)

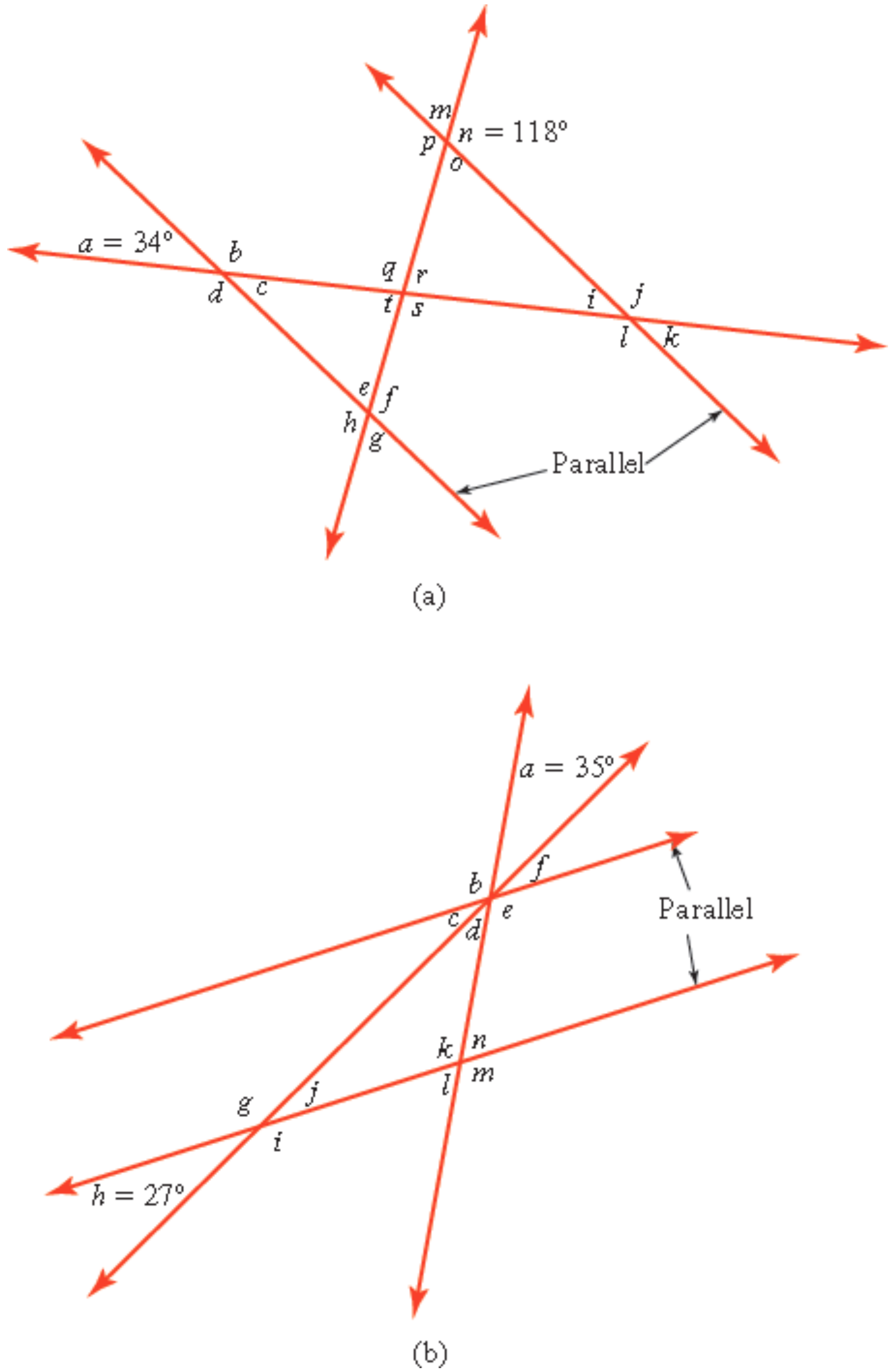


Figure 10.30 Determining the unknown angles in (a) and (b).

3. Given that the indicated lines in **Figure 10.30** (b) are parallel, determine the unknown angles without actually measuring them. Explain your reasoning briefly.

4. Amanda got in her car at point ~~A~~ F and drove to point ~~E~~ A along the route shown on the map in **Figure 10.31**.

10.1 Exercises

a. Trace or redraw Amanda's route shown in **Figure 10.31**; show all of Amanda's angles of turning along her route. Use a protractor to measure p 464

these angles.

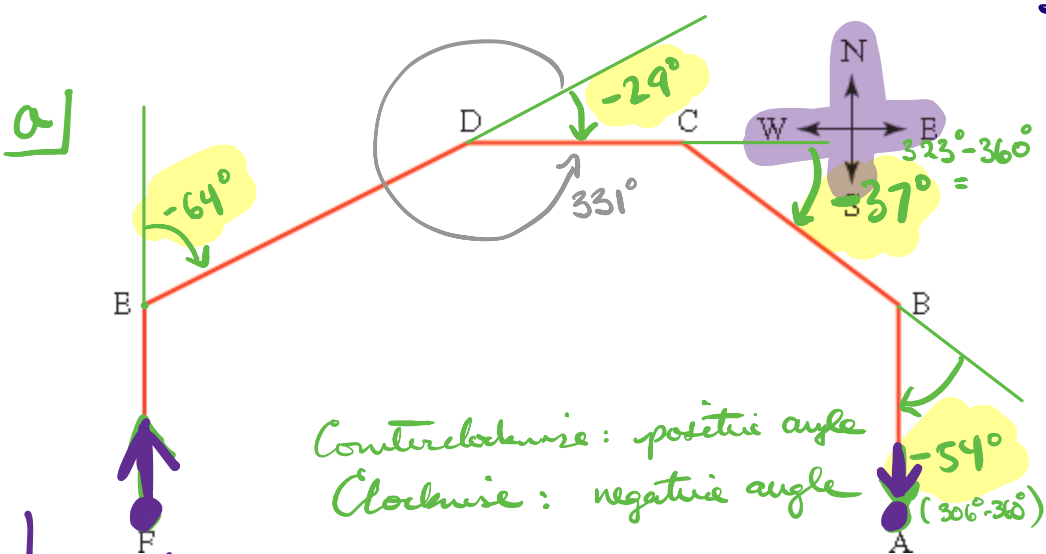
b. Determine Amanda’s total amount of turning along her route by adding the angles you measured in part (a).

c. Now describe a way to determine Amanda’s total amount of turning along her route *without* measuring the individual angles and adding them up. *Hint*: Consider the directions that Amanda faces as she travels along her route.

b)

$-64°$
$-29°$
$-37°$
$-54°$
$-184°$

$\approx -180°$

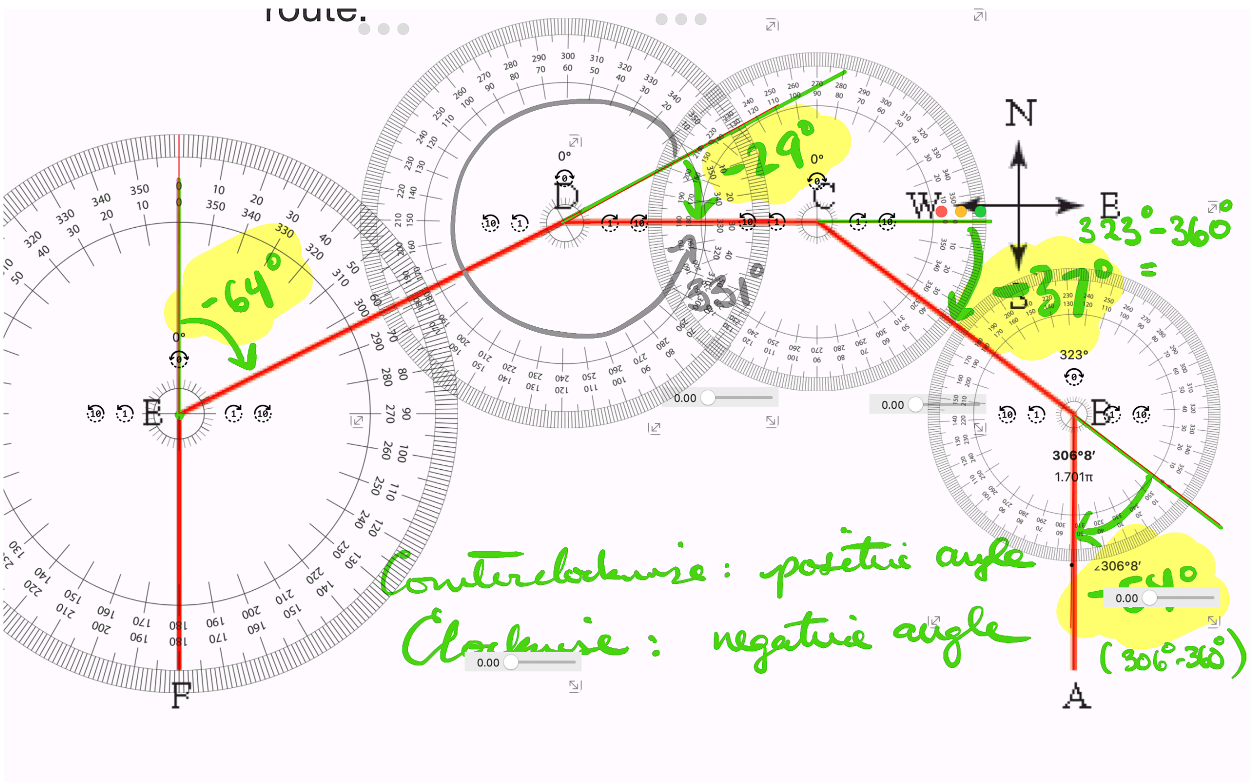


c) Starts out walking <u>north</u>, ends up facing <u>south</u> so she turned 180° to the right (technically $-180°$)

Figure 10.31 Amanda’s route.

5. Ed the robot is standing at point A and will walk to point D along the route shown on the map in **Figure 10.32**. On the map, each segment between two dots represents 10 of Ed’s paces.

a. Trace or redraw the map in **Figure 10.32**. At the points where Ed will turn, indicate his angle of turning. Use a protractor to measure these angles, and mark them on your map.



N
W
E
S
A
B
C
D
E
F
-64°
-29°
331°
-37°
323° - 360° =
323°
306°8′
1.701π
∠306°8′
-54°
(306° - 360°)
Counterclockwise : positive angle
Clockwise : negative angle

How Can We Model with Angles and Sun Rays?

How high or low is the sun in the sky? How long or short is the shadow of a pole standing outside in the sun? These questions are related to the angles that sun rays make with the horizontal ground or the tip of the pole. We can even use these ideas about angles to determine the earth's circumference (i.e., the distance around the earth), as Eratosthenes (275–195 b.c.) of ancient Greece discovered. **Class Activity 10I** is based on Eratosthenes's method.

> Class Activity
> 10I Eratosthenes's Method for Determining the Circumference of the Earth, p. CA-209
>
> From the Field Children's Literature
>
> Lasky, K. (1994). *The librarian who measured the earth*. Boston, MA: Little, Brown and Company. Illustrated by Kevin Hawkes.
>
> This book tells the story of how Eratosthenes, who lived over 2000 years ago, used geometry, camels, plumb lines, and shadows to discover the circumference of the earth. **Class Activity 10I** explores the geometry behind Eratosthenes's method.

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How would you answer the following question?

Question: What causes the seasons?

a. The seasons are caused by the earth moving closer to and farther from the sun.

b. The seasons are caused by the tilt of the earth's axis. The tilt brings one hemisphere closer to the sun, which makes that hemisphere hotter.

c. Both (a) and (b).

d. Neither (a) nor (b).

The seasons *are* caused by the tilt of the earth, but not by proximity to the sun, so the correct answer to the previous question is (d). In fact, the tilt of the earth's axis causes changes throughout the year in how much sunlight a location receives during the day. The tilt of the earth's axis also causes changes throughout the year in the angles that the sun's rays make with the horizontal ground and therefore how intensely we feel the sunlight. You can explore connections between angles, sunlight, and seasons in the problems at the end of this section.

Summer in the northern hemisphere

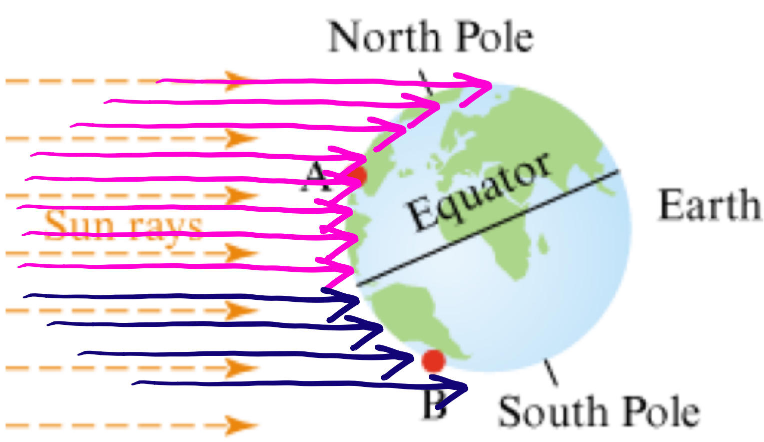
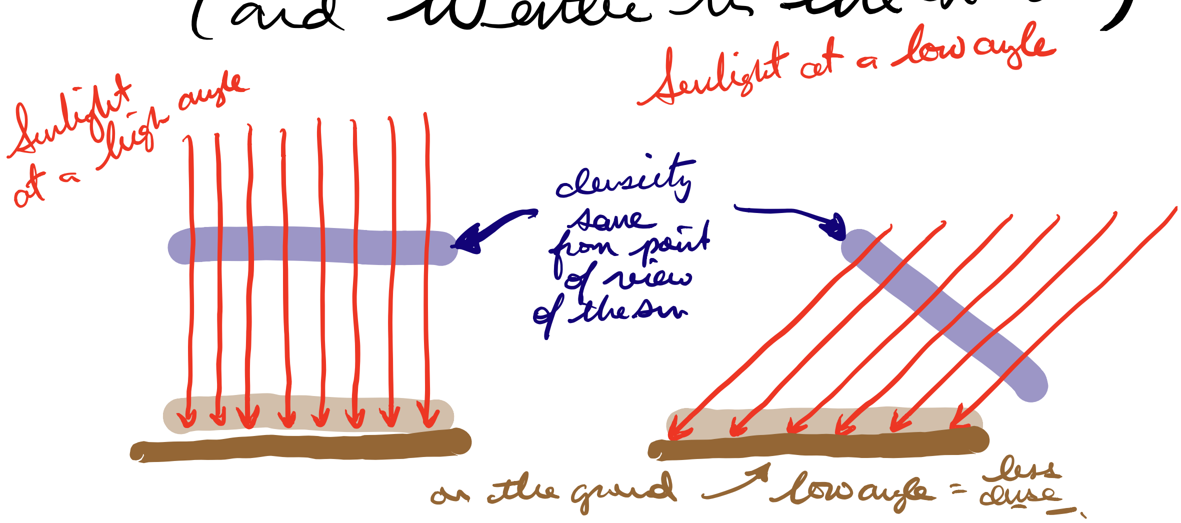


Figure 10.50 Earth and sun.

Think of each ray of sunlight as having the same amount of energy.
Northern hemisphere gets more of them than Southern hemisphere when it's summer in the north
(and Winter in the south)



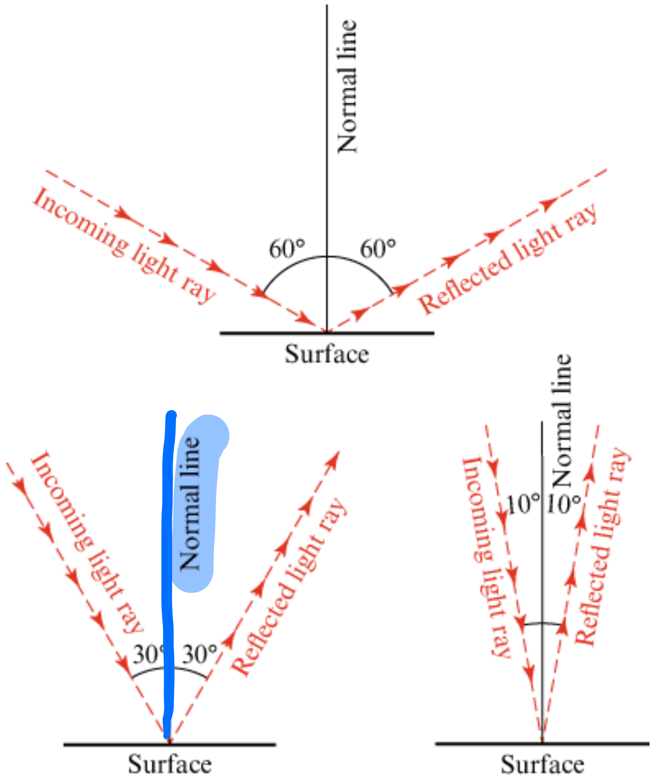


Figure 10.39 Light rays reflecting off surfaces.

normal line comes out from the mirror perpendicular

You can demonstrate the reflection laws by putting a mirror on a table, shining a penlight at the mirror, and seeing where the reflected light hits the wall. (Be careful to keep the light beam away from all observers' eyes.) If you raise and lower the light, while still pointing it at the mirror, the light beam traveling toward the mirror will form different angles with the mirror. By observing the reflected light beam on the wall, you can tell that the light beams going toward and from the mirror make the same angle with the normal line to the mirror. (If the mirror is on a horizontal table, then the normal lines to the mirror are vertical.)

Class Activities 10J and 10K show some interesting consequences of the laws of reflection.

> Class Activity
> 10J Why Do Spoons Reflect Upside Down?, p. CA-210
>
> 10K How Big Is the Reflection of Your Face in a Mirror?, p. CA-210

Section Summary and Study Items

Section 10.2 Angles and Phenomena in the World

Angles arise in real-world situations. For example, angles are formed by the sun’s rays and angles describe reflected light rays.

Key Skills and Understandings

1. Apply the laws of reflection to explain what a person looking into a mirror will see.

Practice Exercises for Section 10.2

1. Make math drawings to show the relationship between the angle that the sun’s rays make with horizontal ground and the length of the shadow of a telephone pole.
2. **Figure 10.40** shows several math drawings (from the point of view of a fly looking down from the ceiling) of a person standing in a room, looking into a mirror on the wall. The direction of the person’s gaze is indicated with a dashed line. What place in the room will the person see in the mirror?

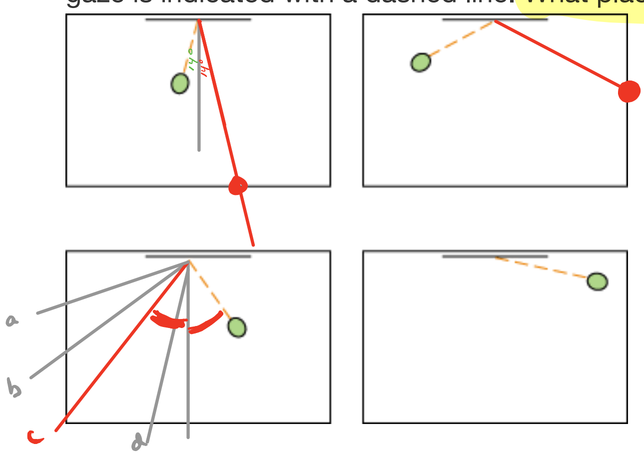


Figure 10.40 Looking into a mirror.

3. **Figure 10.41** shows a mirror seen from the top, and a light ray hitting the mirror. Draw a copy of this picture on a blank piece of paper. Use the following paper-folding method to show the location of the reflected light ray:
   - Fold and crease the paper so that the crease goes through the point where the light ray hits the mirror and so that the line labeled “mirror” folds onto itself. (This crease is perpendicular to the line labeled “mirror.” You’ll be asked to explain why shortly.)
   - Keep the paper folded, and now fold and crease the paper again along the line labeled “light ray.”
   - Unfold the paper. The first crease is the normal line to the mirror. The second crease shows the light ray and the reflected light ray.

   a. Explain why your first crease is perpendicular to the line labeled “mirror.”
   b. Explain why your second crease shows the reflected light ray.

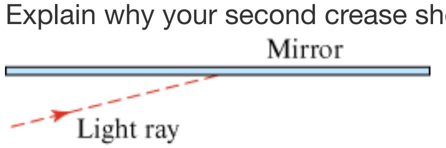


Figure 10.41 Using paper folding to find the reflected ray.

CA-209

10.2 Angles and Phenomena in the World

Class Activity 10I Eratosthenes's Method for Determining the Circumference of the Earth

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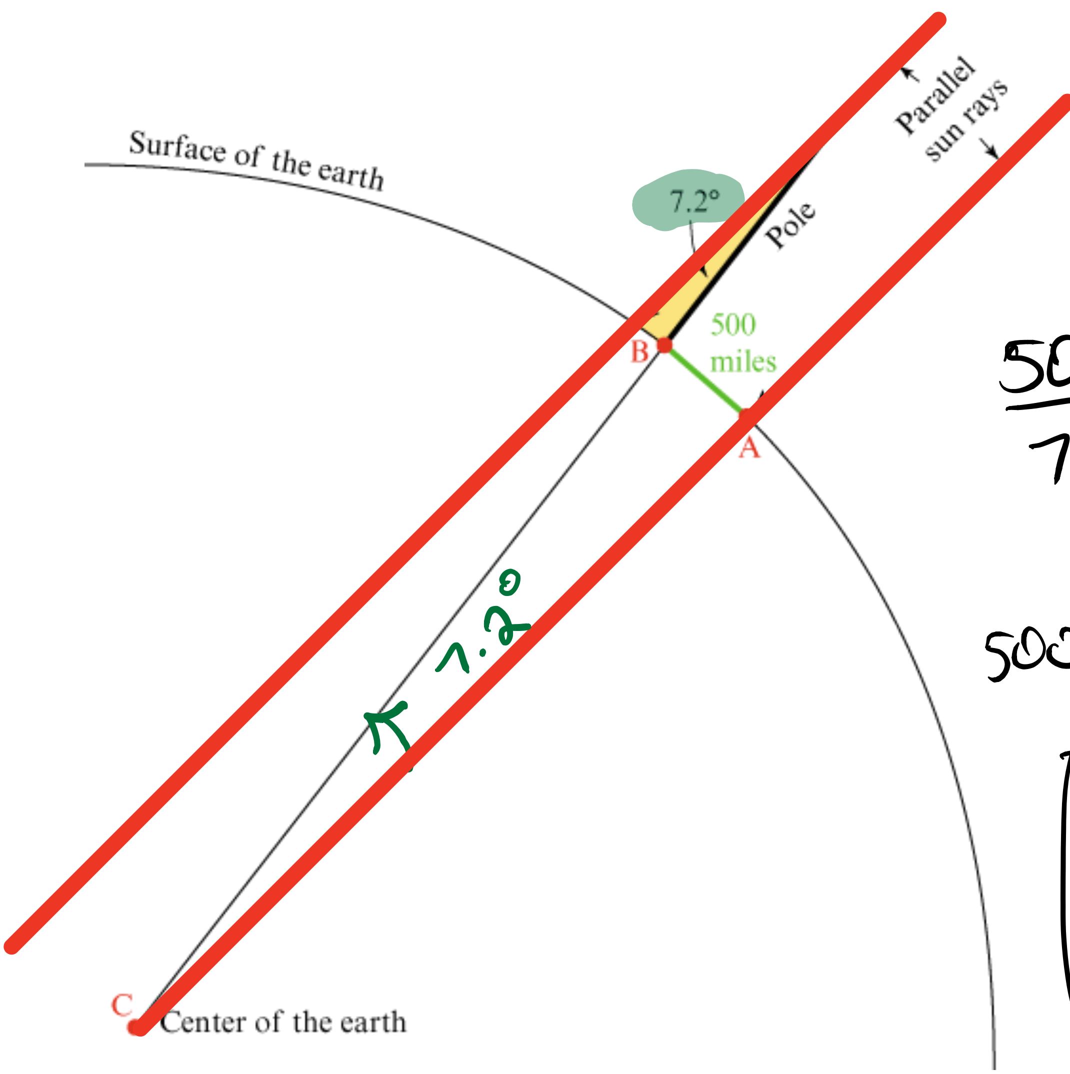
The figure below shows a cross-section of the earth. At noon on June 21, the sun is directly overhead at location A, so that the sun's rays are perfectly vertical there. At the same time, 500 miles away at location B, the sun's rays make a 7.2° angle with the tip of a vertical pole (shown not to scale), which was determined by considering the shadow that the pole casts. Because the sun is far away, sun rays at the earth are (approximately) parallel. Use this information to determine the circumference of the earth, explaining your reasoning.



$$\frac{500\text{ mi}}{7.2^\circ} = \frac{x}{360^\circ}$$

$500 \cdot 360 / 7.2$

$$\boxed{= 25000\text{ mi} \approx \text{circumference of the earth}}$$